ALTERNATIVE FUELS FOR AVIATION
EXPECTED ENVIRONMENTAL BENEFITS
SUPPORTING POLICY LANDSCAPE

Prussi M.

The views expressed here are purely those of the authors and may not, under any circumstances, be regarded as an official position of the European Commission.

***EC-JRC** - Unit C.2*
Ispra (IT)

Environmental impact of civil aviation

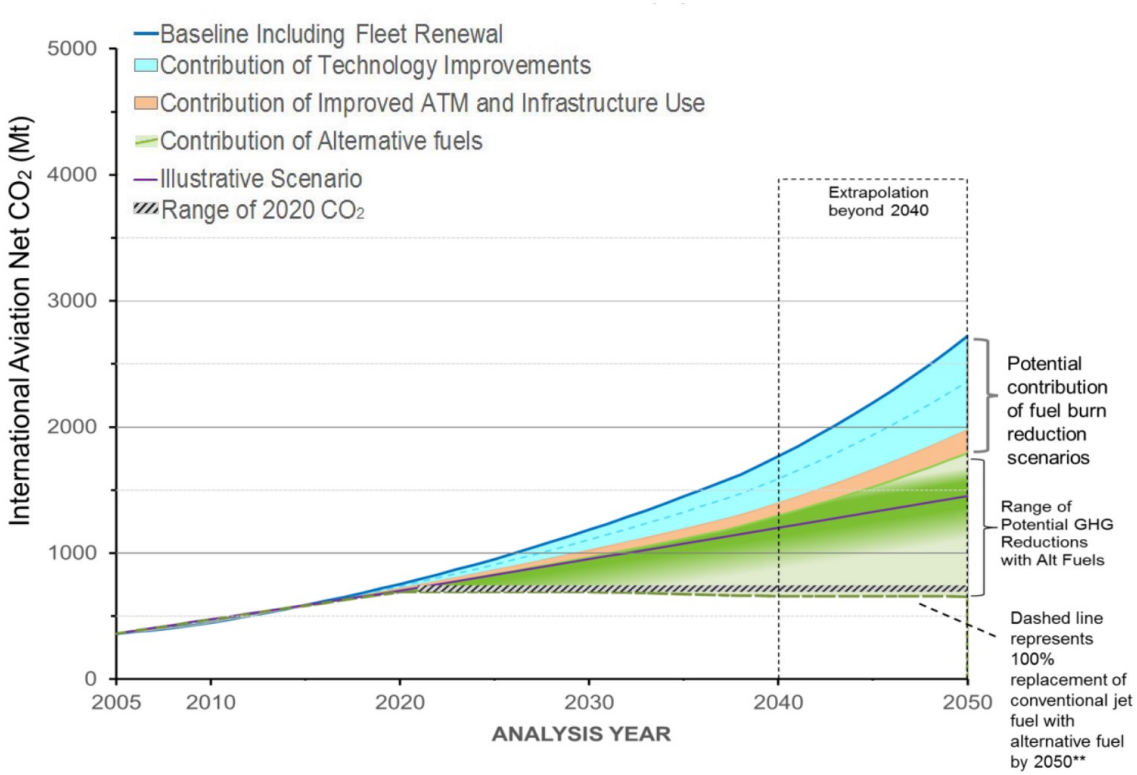
Why we need to decarbonise the sector

European Commission

GHG impact of international aviation

- Before COVID pandemic, international civil aviation was **consuming about 160 megatons (Mt) of fuel**, corresponding to approximately **2.6% of GHG emissions** from fossil fuel combustion.

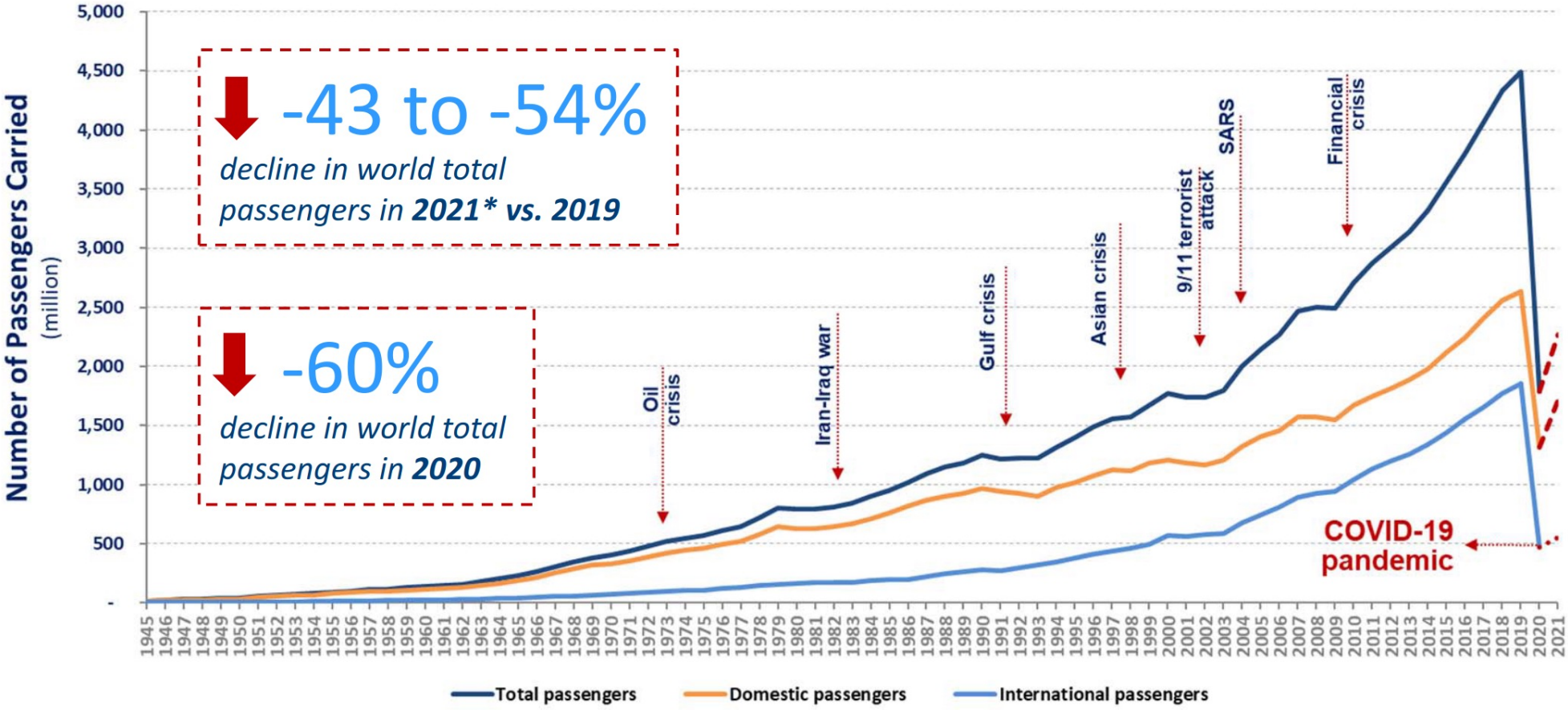
- The sector **was growing at a significant pace**: before the COVID-19 crisis, ICAO forecasted that by 2050 international aviation **emissions could triple** compared with 2015.



https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg17-23.pdf

European Commission

World passenger traffic evolution
1945 – 2021*



https://www.icao.int/sustainability/Documents/Covid-19/ICAO_coronavirus_Econ_Impact.pdf

European Commission

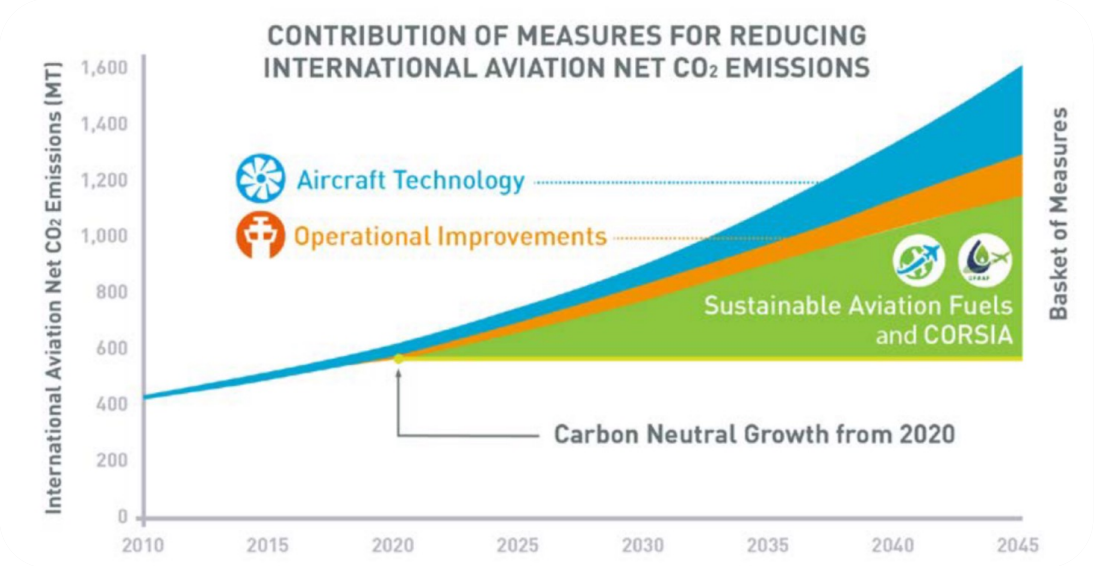
SAF for aviation

Alternative fuels for GHG impact mitigation

ICAO'S ASPIRATIONAL GOALS & BASKET OF MEASURES - **CORSIA**

- **In 2016, ICAO/CAEP** the **C**arbon **O**ffsetting and **R**eduction **S**cheme for **I**nternational **A**viation (**CORSIA**).

- CORSIA requires **airline operators to offset GHG emissions => SAF**.



European Commission

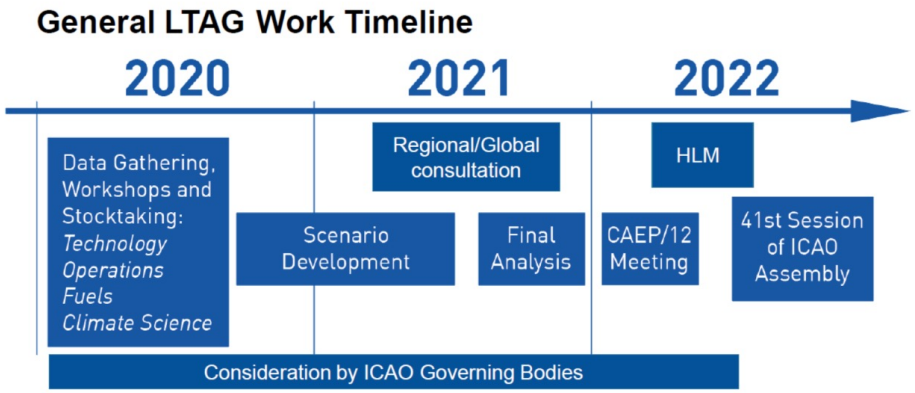
CORSIA CEF

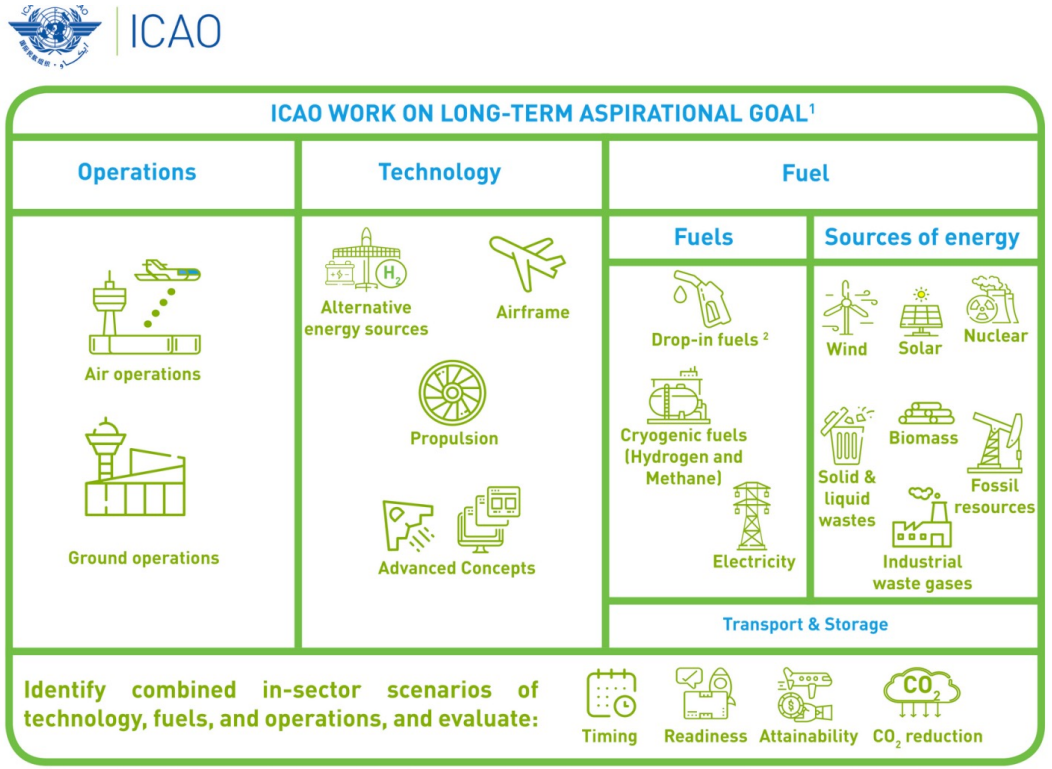
- Historically, terms such as “**alternative fuels**” or “**sustainable fuels**” have been used in many instances to designate fuels produced from non-conventional processes and, consequently**, lower environmental impact**.
- **CORSIA eligible fuel (CEF)**. A CORSIA sustainable aviation fuel or a CORSIA lower carbon aviation fuel, **which an operator may use to reduce their offsetting requirements**.
  - **CORSIA sustainable aviation fuel- SAF**. A renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria under this Volume.
  - **CORSIA lower carbon aviation fuel - LCAF**.A fossil-based aviation fuel that meets the CORSIA Sustainability Criteria under this Volume.

European Commission

ICAO'S ASPIRATIONAL GOALS

- **ICAO/CAEP/LTAG TG** is re-discussing the **Long Term Aspirational Goal**.





European Commission

EU legislative landscape

- The **European Green Deal** (EGD): the overarching policy framework from the European Commission released in December 2019, aims to achieve a climate neutral continent in 2050.
- the **2030 Climate Target Plan**: adopted in September 2020 also urges to scale up efforts to improve the efficiency of aircraft, ships and their operations and to increase the use of sustainably produced renewable and low-carbon fuels .
- **Renewable Energy Directive** (REDII): pursue the decarbonisation of the economy, including the transport sector.
- **ETS**. CO2 emissions from aviation have been included in the EU emissions trading system (EU ETS) since 2012. The EU decided to limit the scope of the EU ETS to flights within the EEA until 2016 to support the development of CORSIA.
- **ReFuelEU Aviation**: legislative initiative to increase the SAF consumption in the EU.

European Commission

EU-27 SAF demand for aviation

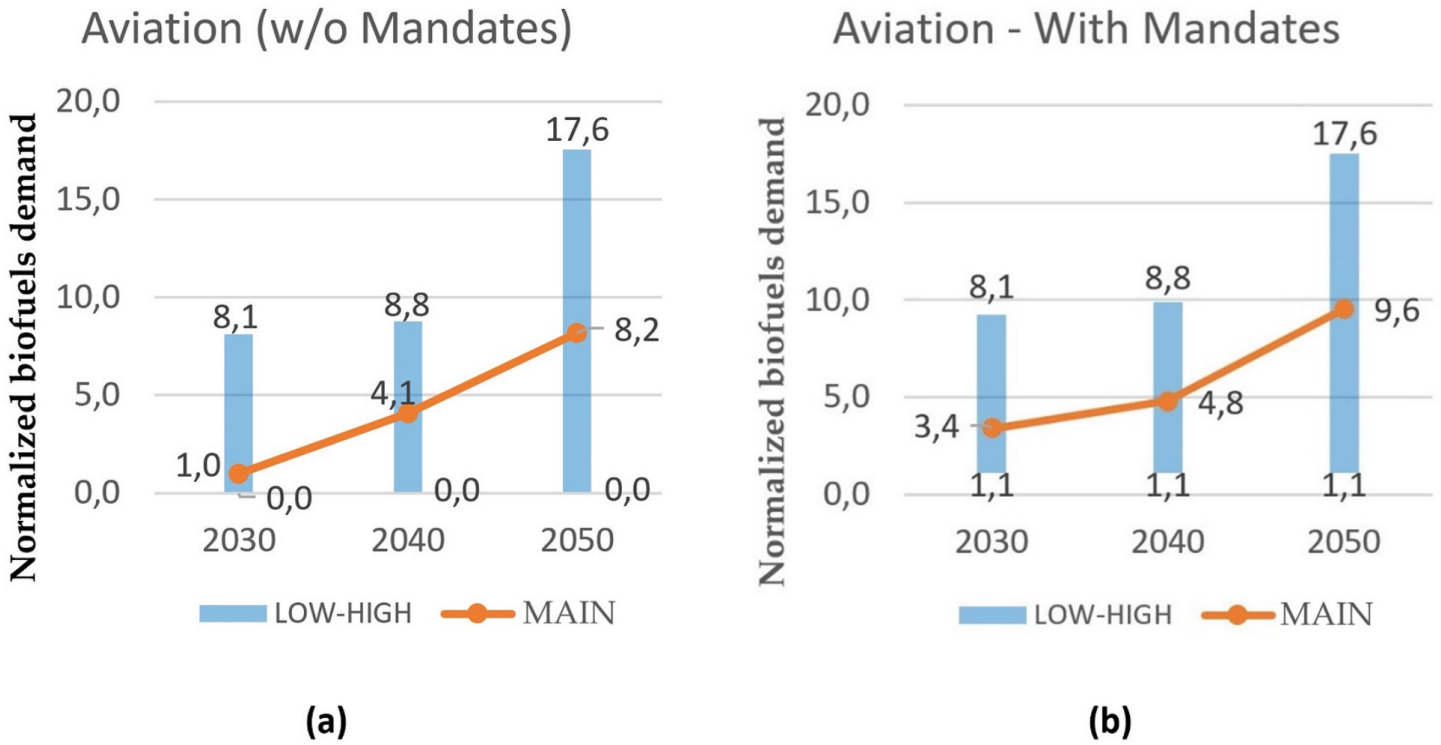


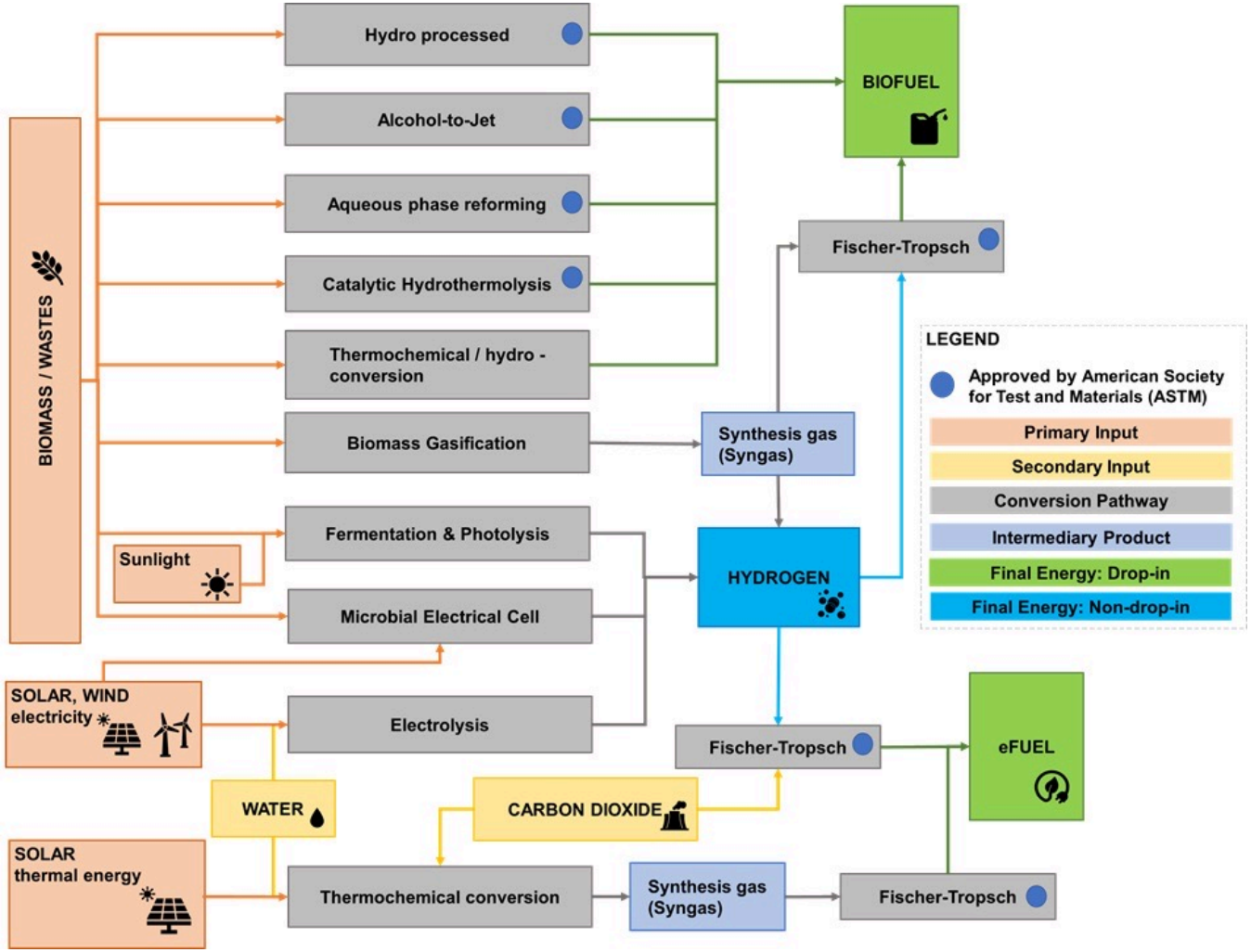
Fig. 13. Sub-sectorial biofuels consumption forecasts within the three scenarios. (a) highlights the finding for the aviation sector. The 2030 MAIN scenario normalised value of 1.0 equals to 1.8 MTOE in absolute terms, as described by Table 1; (b) highlights the finding for the aviation sector when MSs' mandates are taken into account. The 2030 MAIN scenario normalised value of 1.0 equals to 5.9 MTOE in absolute terms, as described by Table 1.

Chiaramonti, D., Talluri, G., Scarlat, N., & Prussi, M. (2021). **The challenge of forecasting the role of biofuel in EU transport decarbonisation at 2050: A meta-analysis review of published scenarios.** *Renewable and Sustainable Energy Reviews, 139*, 110715.

ASTM Certified Pathways

Fuels allowed for commercial flights

Alternative Fuels for aviation



TU Delft and NRL hosted the "Workshop on Sustainable Aviation Fuels for Aircraft Propulsion" (Oct.2020)

European Commission

ASTM certfied SAF

Table 1
TRL and FRL of the five ASTM-Certified pathways.

Process		TRL	FRL
Fischer-Tropsch Synthetic Paraffinic Kerosene	**FT-SPK**	6–8	6-7
Hydroprocessed Fatty Acid Esters and Free Fatty Acid	**HEFA**	9	9
Hydroprocessing of Fermented Sugars - Synthetic Iso-Paraffinic kerosene	**HFS–SIP**	7–8	5–7
Fischer-Tropsch Synthetic Paraffinic Kerosene with Aromatics	**FT-SPK/A**	6–8	6-7
Alcohol-to-Jet- Synthetic Paraffinic Kerosene	**ATJ-SPK**	7–8	7

Prussi, M., O'Connell, A., & Lonza, L. (2019). ***Analysis of current aviation biofuel technical production potential in EU28.*** *Biomass and Bioenergy, 130, 105371.*

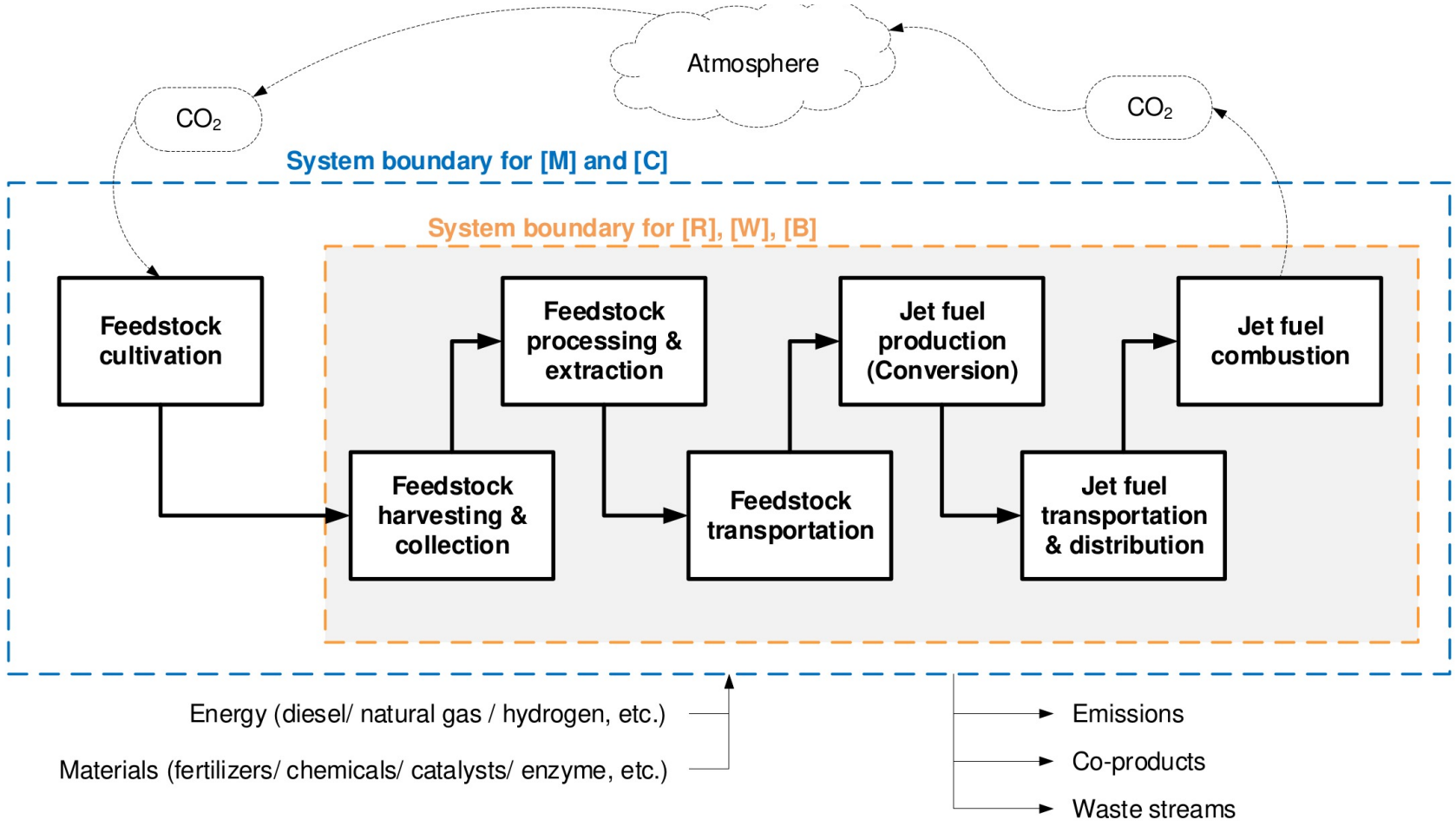
European Commission

Expected enviromet nal benefits

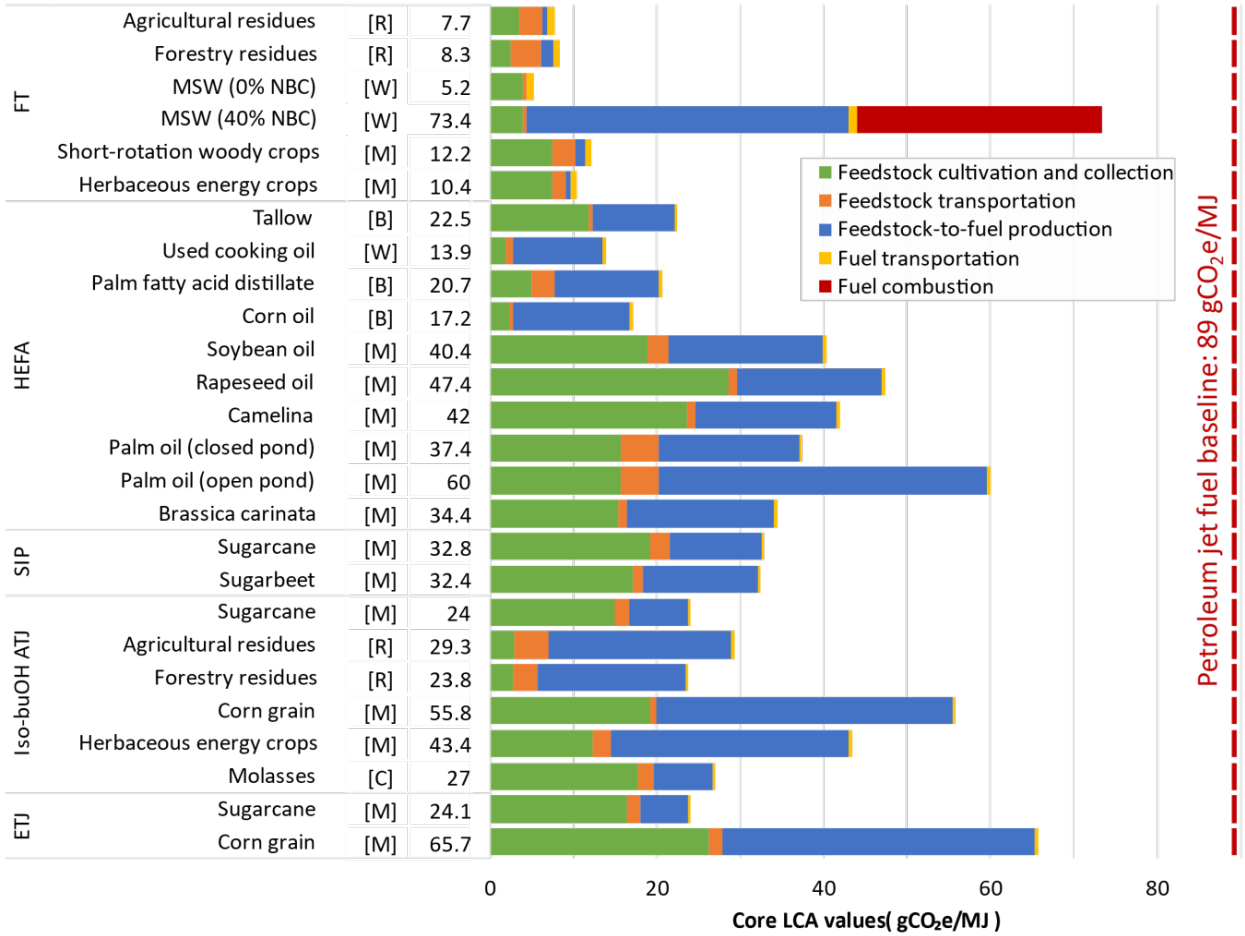
GHG and other expected impacts

CORSIA methodology

$$\text{Core LCA } [gCO_2e/MJ] = e_{fe\_c} + e_{fe\_hc} + e_{fe\_p} + e_{fe\_t} + e_{fefu\_p} + e_{fu\_t} + e_{fu\_c}$$



Default core LCA values of SAF production pathways approved by ICAO to date.



(NBC: non-biogenic carbon content)

Under publication

European Commission

ILUC

- Direct Land Use Change Emissions (**DLUC**): land converted to produce the feedstock needed forfuel produciton.
- Indirect Land Use Change Emissions (ILUC): refers to the **global market-mediated agricultural area expansion** in response to the increased biofuel demand.
    - If crops grown on existing arable land are used to make biofuels and are diverted from food and feed production, then the gap in the food supply will be partly filled by the expansion of cropland, because of the necessity to replace the food production.
    - The expansion may happen in areas with high carbon stock such as forests, wetlands and peatlands.

Table 1. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

Fuel Conversion Process	Region	Fuel Feedstock	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Fischer-Tropsch (FT)	Global	Agricultural residues	7.7	0.0	7.7
	Global	Forestry residues	8.3		8.3
	Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)	5.2		5.2
	Global	Municipal solid waste (MSW) (NBC given as a percentage of the non-biogenic carbon content)	NBC*170.5 + 5.2		NBC*170.5 + 5.2
	USA	Poplar (short-rotation woody crops)	12.2	-5.2	7.0
	USA	Miscanthus (herbaceous energy crops)	10.4	-32.9	-22.5
	EU	Miscanthus (herbaceous energy crops)	10.4	-22.0	-11.6
	USA	Switchgrass (herbaceous energy crops)	10.4	-3.8	6.6
Hydroprocessed esters and fatty acids (HEFA)	Global	Tallow	22.5	0.0	22.5
	Global	Used cooking oil	13.9		13.9
	Global	Palm fatty acid distillate	20.7		20.7
	Global	Corn oil (from dry mill ethanol plant)	17.2		17.2
	USA	Soybean oil	40.4	24.5	64.9
	Brazil	Soybean oil	40.4	27.0	67.4
	EU	Rapeseed oil	47.4	24.1	71.5
	Malaysia & Indonesia	Palm oil – closed pond	37.4	39.1	76.5
	Malaysia & Indonesia	Palm oil – open pond	60.0	39.1	99.1

Fossil kerosene comparator 89 gCO2/MJ

European Commission

Conclusions

Take home messages

European Commission

Take-home messages

- **Aviation** is expected to rapidly recover from COVID-19 pandemic, continuing **increasing its growth**, with a significant associated **environmental impact**.
- **Aviation** is expected to **rely on liquid fuels** in the shot-medium term, expecially for **the long-haul flights**.
- At **international level**, **ICAO-CORSIA** is supposed to contribute to sector decarbonisation, by **required operator to offset their emissions**.
- **Sustainable Aviation Fuels** are considered an **effective tool** for the sector **decarbonisation strategy**.

European Commission

Take-home messages

- At **European level** many **legislative acts** and **initiatives** are **supporting** the uptake of **SAF**.
- **Sustainable aviation fuels** (SAFs) as defined in CORSIA can **reduce life-cycle GHG emissions by over 90%.**
- However, while SAFs could play a major role in contributing to reducing aviation sector's GHG emissions on the basis of their per-MJ GHG reduction potentials, **caution is needed** as today **cost barriers have to be overcome** in order to ensure the large-scale deployment of SAFs, and the corresponding GHG emissions benefits.

European Commission

Thank you

The views expressed here are purely those of the authors and may not, under any circumstances, be regarded as an official position of the European Commission.